Mercury Concentrations in Kansas Surface Waters

Our Mission: To protect and improve the health and environment of all Kansans.

Mercury Concentrations in Kansas Surface Waters

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Bureau of Water
Watershed Planning, Monitoring and Assessment

Kansas Department of Health and Environment

Outline of Discussion

- **Overview of the Problem with Mercury**
- **What is Mercury (Forms and Behavior)**
- **Exposure to Mercury**
- **Key Terms and Principles**
- **Environmental Occurrence in Kansas**
  - **Airborne Deposition**
  - **Water Column: Streams, Lakes and Wetlands**
  - **Fish Tissue**
- **KDHE Fish Tissue Mercury Timelines**
  - **Mercury Tissue Data Assessment**
- **Health Risk**
- **Key Take-Home Points**

Overview of Problem

Minamata Bay, Japan

•An environmental disaster, that occurred in the early 1950s to 1960.

• Minamata disease, a toxic disorder of the central nervous system caused by heavy-metal poisoning from eating the fish and shellfish of Minamata Bay.

•The root cause of the disorder was determined to be high concentrations of mercury that was discharged from a plastic-producing chemical plant.

Photo credit: Japanfocus.org

What is Mercury

Mercury occurs almost everywhere in the environment and exists in several forms

- **Elemental mercury** aka metallic mercury (e.g., thermometers, electric switches, fluorescent lamps, and dental fillings)

- **Inorganic mercury compounds** combined with other chemical elements such as chlorine, sulfur, or oxygen

- **Organic mercury** combined with carbon-containing compounds (e.g., methylmercury is a common form produced by microorganism in water, soil, and gastrointestinal tract of humans via methylation)

- Both inorganic an organic mercury compounds can exist as salts

Exposure to Mercury

- **Elemental mercury (Hg):** breathing air containing elemental mercury vapor in confined spaces (e.g., after breaking a mercury thermometer) and from dental amalgams (fillings)

- **Inorganic mercury compounds (e.g., mercuric chloride):** skin contact (beauty products) or historically from medicines or vaccines

- **Organic mercury (e.g., methylmercury):** eating certain fish from freshwater (e.g., black bass, walleye and pike); marine (tuna, swordfish, shark)

Key Terms and Principles

• **Metal speciation** is determination of form(s) of an element in a sample (e.g., elemental mercury vs. mercuric ion vs. methyl mercuric ion)

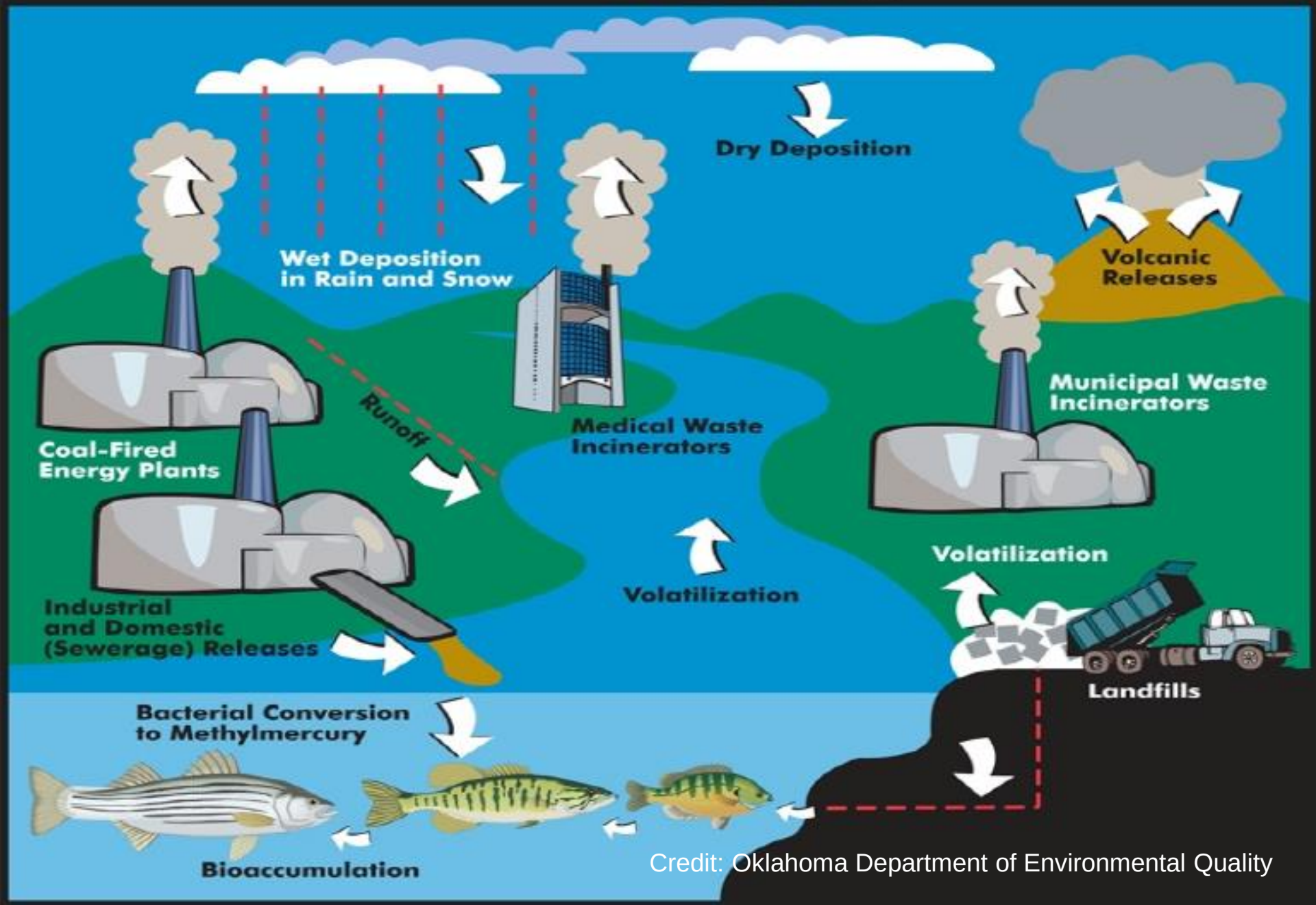
- **Reporting Units (mg/L = ppm; µg/L = ppb; ng/L = ppt)**
  - **Analogies** [1]
  - **1 ppm – 8.34 pounds in 1 million gallons of water**
  - **1 ppb – 1 pound in 120 million gallons of water**
  - **1 ppt – 1 ounce in 7.5 billion gallons of water**

- **Bioaccumulation** occurs when the contaminate increases within the organism faster than it's eliminated

- **Biomagnification** is a process that increases the contaminate concentration as it travels up the food chain

[1]*Adapted and modified from: www.seagrant.umn.edu/.../report/helpfulinformation/**concentrations**.pdf*

The Mercury Cycle



Credit: Oklahoma Department of Environmental Quality

The Mercury Food Web

Predator Fish

Invertebrates → Forage Fish

Benthos

Detritous → Periphyton → Phytoplankton

Credit: Oklahoma Department of Environmental Quality

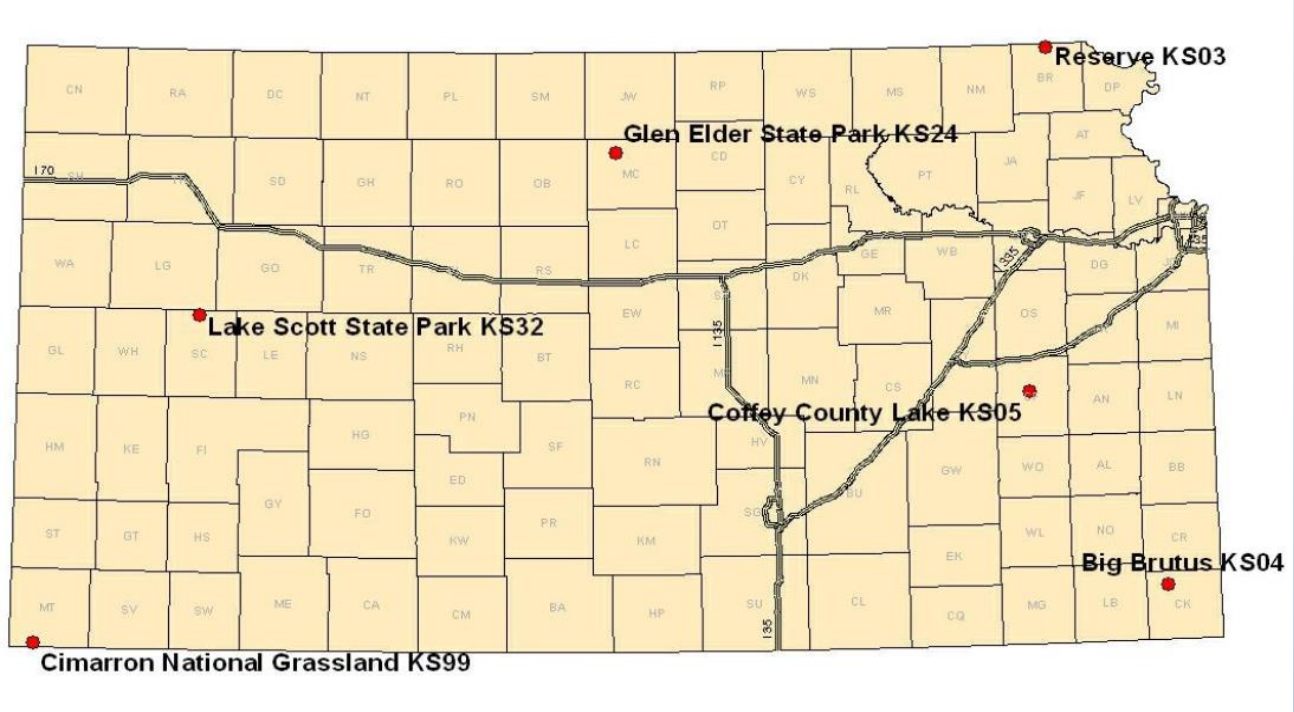
Environmental Occurrence in Kansas

KDHE Mercury Wet Deposition Network

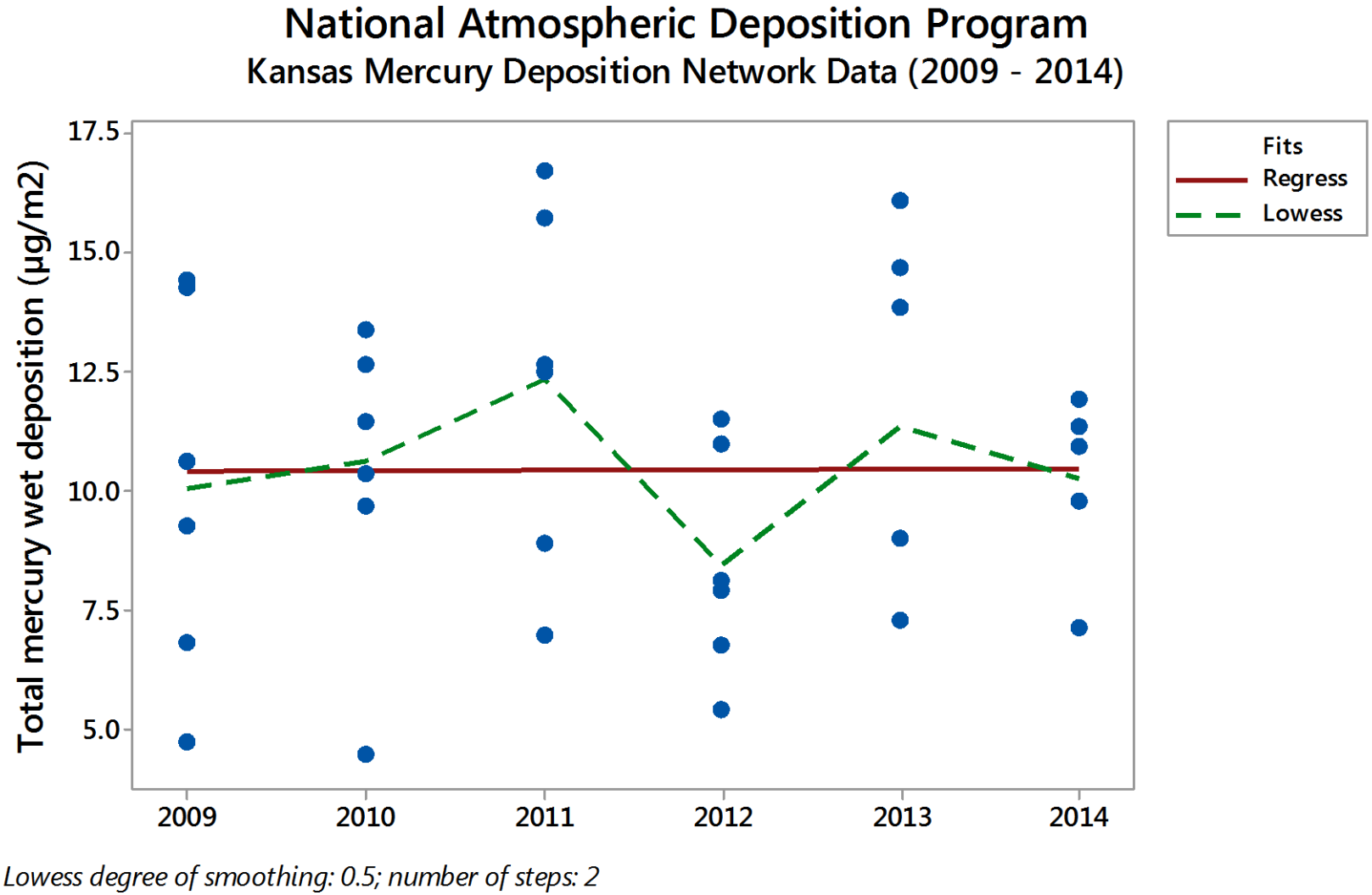
- **Established by the KDHE's Bureau of Air in 2009**
- **Samples collected from six sites (2009 – 2014)**
- **Sampling typically performed on a weekly basis**

The Bureau of Air Mercury Deposition Network currently has four sites and two inactive sites in Kansas to evaluate wet deposition patterns of total mercury in precipitation as part of the National Atmospheric Deposition Program

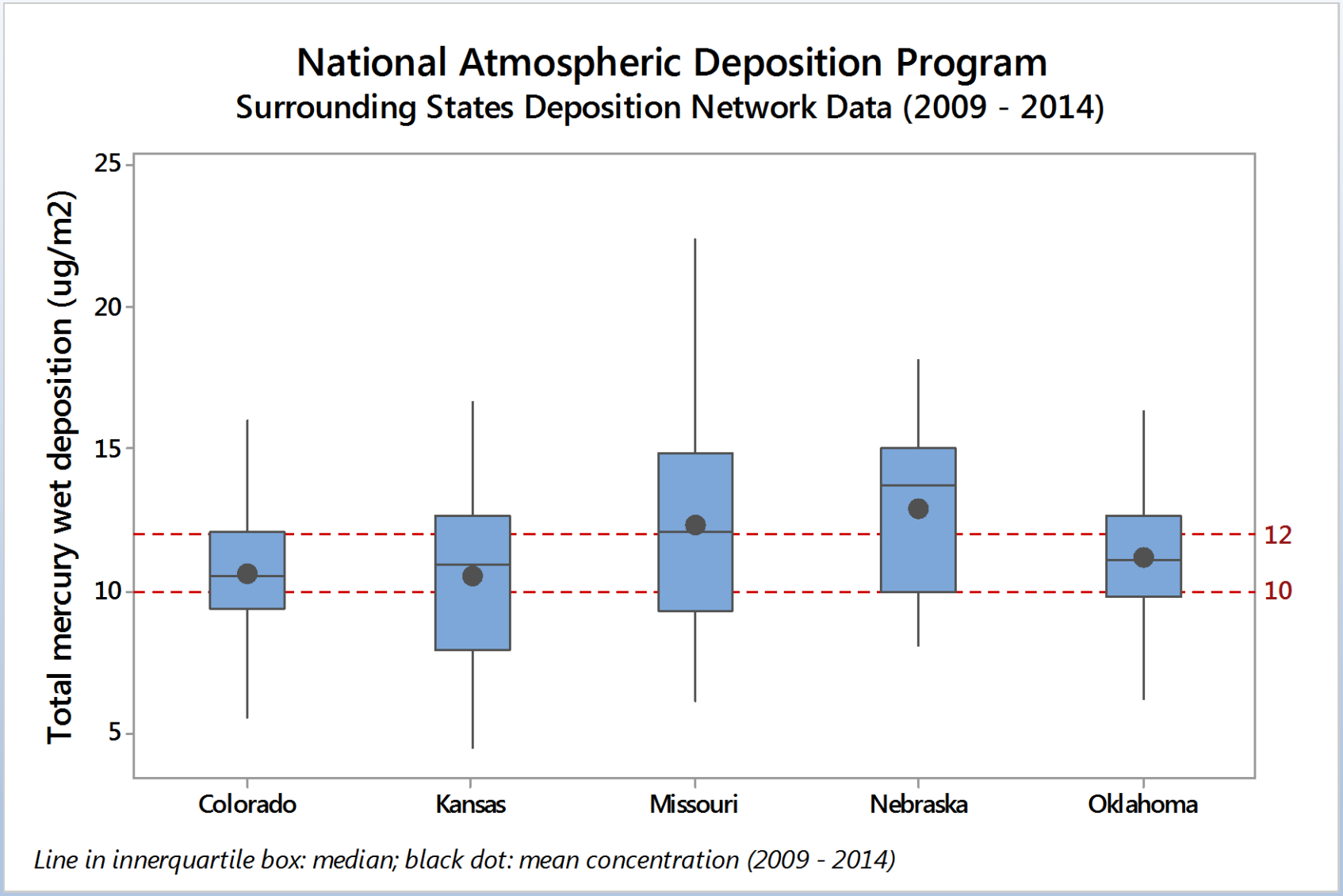
KDHE Mercury Wet Deposition Network



KDHE's Bureau of Air Mercury Deposition Network provides annual data for the National Mercury Deposition Program. A detailed report on this network is viewable online at: http://www.kdheks.gov/bar/air-monitor/mercury/Hg_Report.pdf

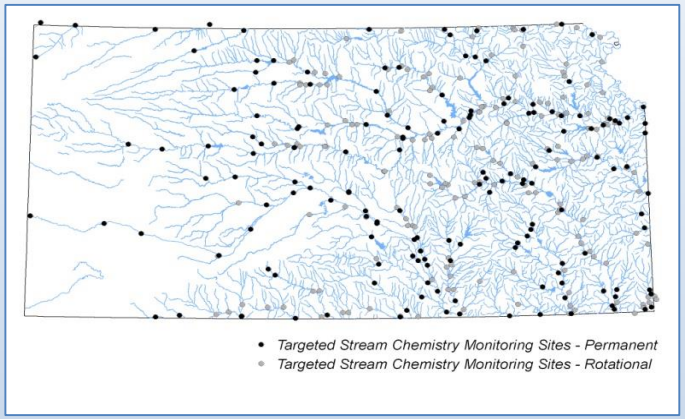


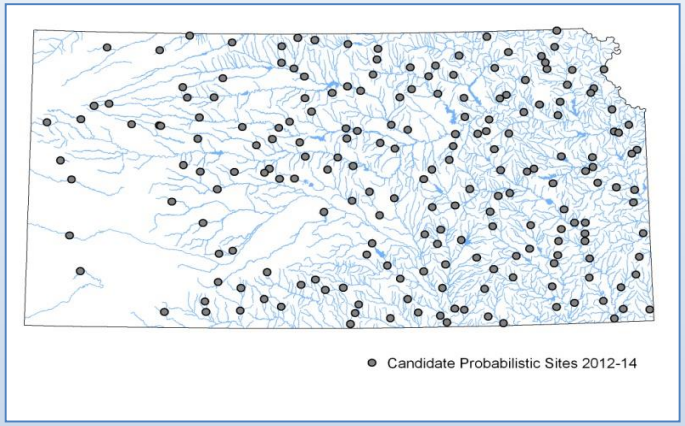
From 2009 – 2014, the total mercury wet deposition rates (among sites) has remained fairly consistent (i.e., no significant change in data over time). The data indicate most sites in Kansas pickup on average between 10 and 12 micrograms of mercury per square meter.

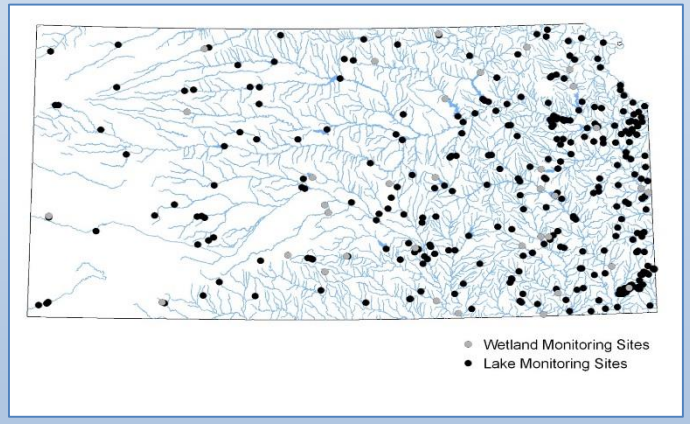


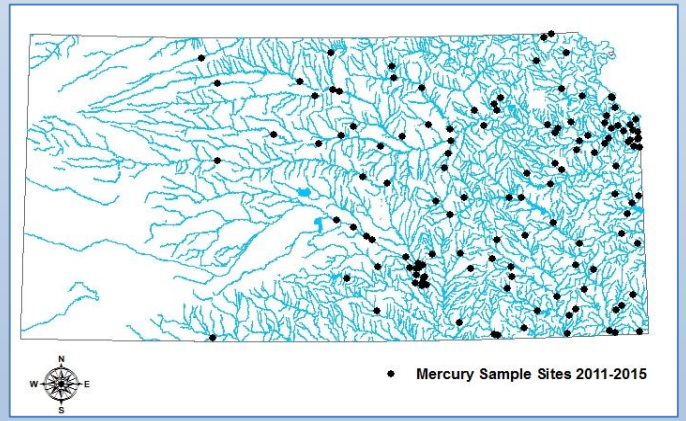
The mercury deposition levels observed in Kansas fall in the middle spectrum when compared to levels measured in our surrounding states (same time period and sample frequency).

KDHE Surface Water Quality Monitoring Networks









KDHE's BOW Quality Management Plans for these programs are viewable online at: http://www.kdheks.gov/environment/qmp/qmp.htm

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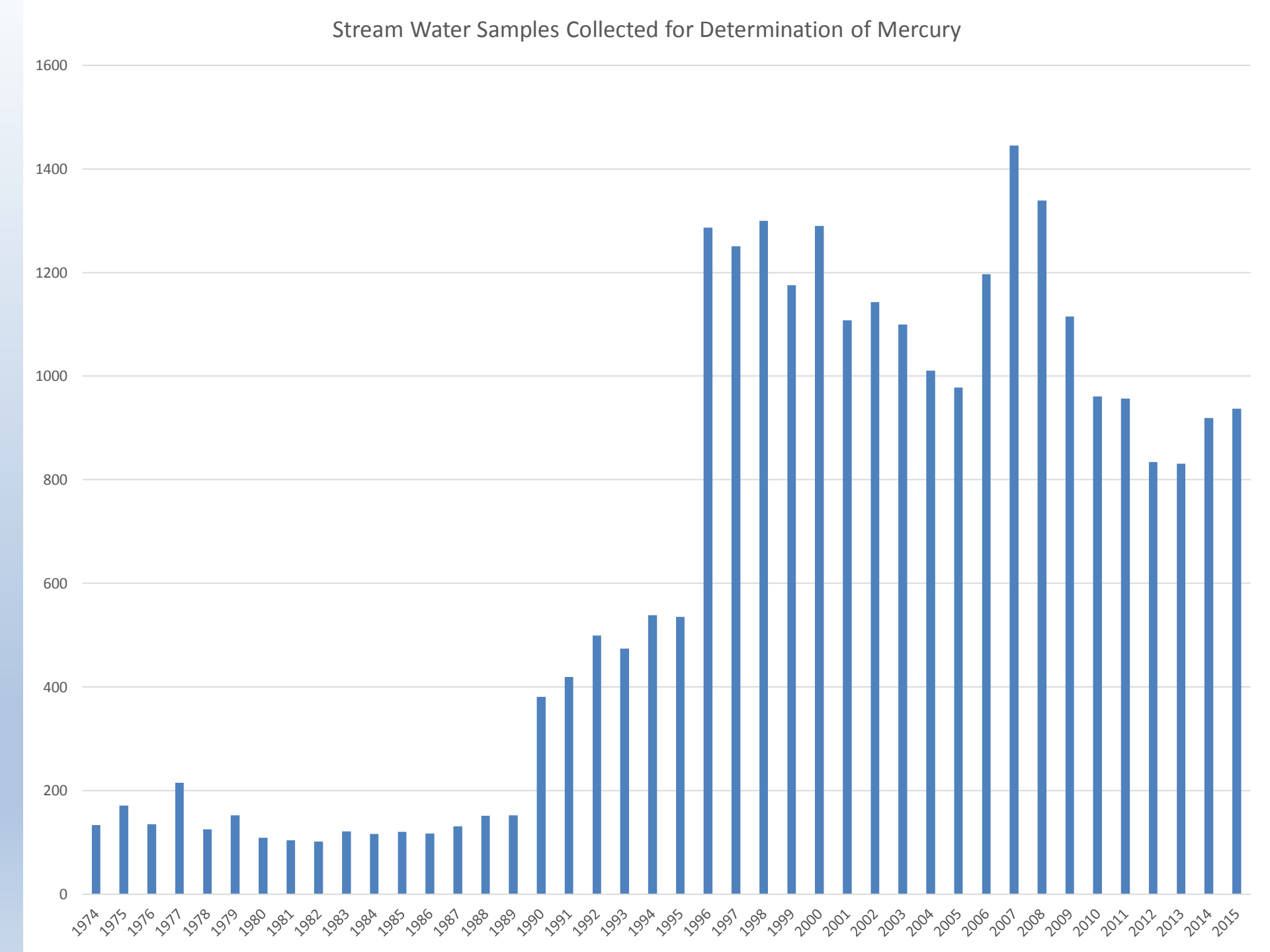
KDHE Rivers and Streams Monitoring

Stream Chemistry Program

- Established ~ 1967 (resemblance of current operations)
- Quarterly samples at core (every year) and rotational (every fourth year) stations
- Comprises 329 active monitoring sites: 160 core and 168 rotational
- ~ 200 core and rotational stations per year (~400 current and historical sites)

Stream Probabilistic Program

- Established 2006
- Samples for both chemistry and biology
- Spatially balance random site selection (~30-50 sites/year
- Work collaboratively with target programs
- Unweighted design (i.e., emphasis on smaller stream systems in Kansas)
- Biennial sampling of 25-34 reference-water quality stations


Stream Water Samples Collected for Determination of Mercury
1600
1400
1200
1000
800
600
400
200
0
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
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2009
2010
2011
2012
2013
2014
2015

Mercury Concentrations in Streams

- **KDHE retains over 27,000 historical measurement records of total recoverable mercury concentrations in Kansas streams.**
- **98.7% of the total recoverable mercury concentrations are below the minimum quantification limit of 0.5 parts per billion (ppb).**

Mercury Statistical Summary (Data years: 1974 – 2015)

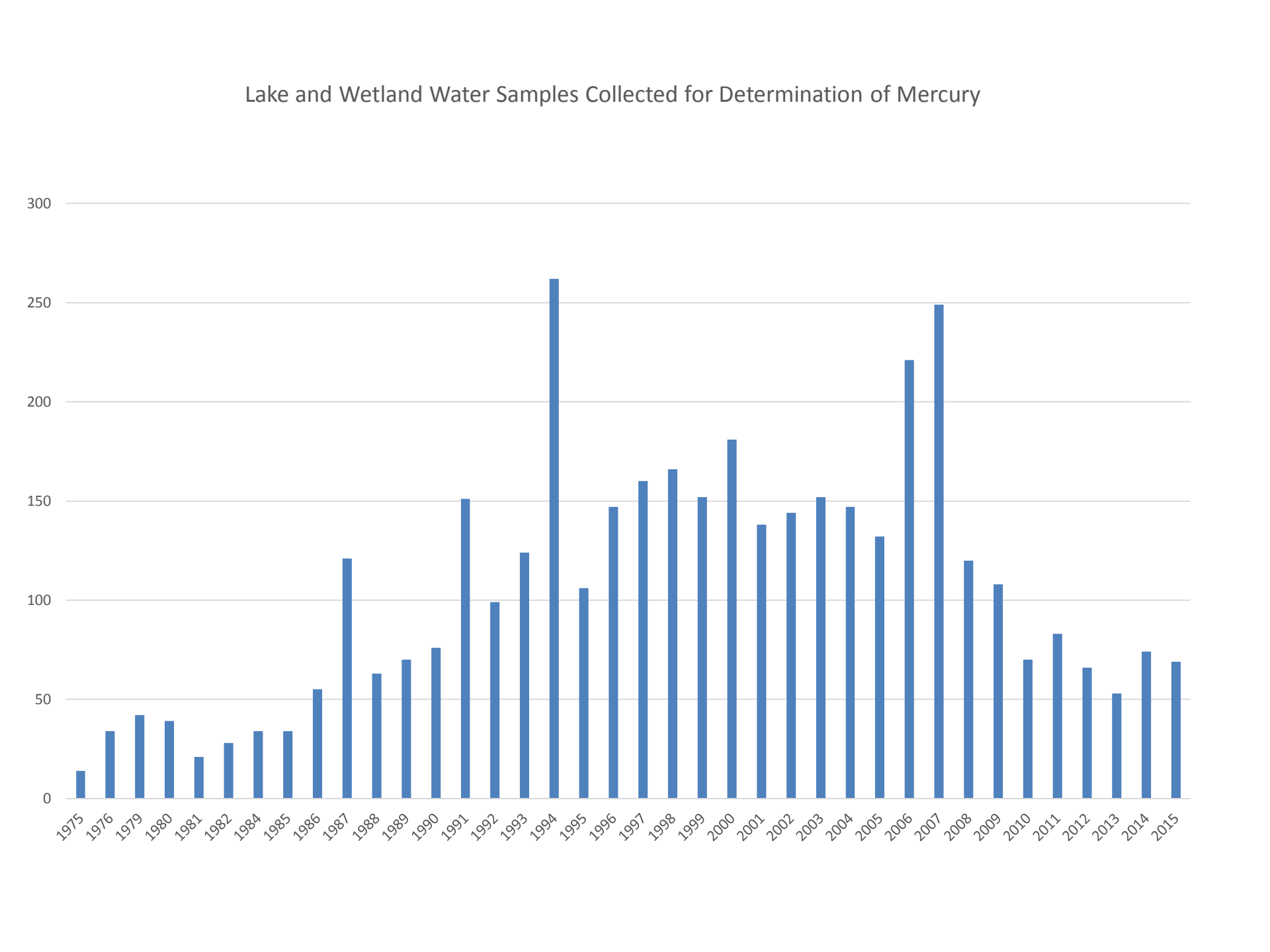
Sample Type	Obs.	ND	DT	%DT	Mean	Median	Min	Max
Streams	27178	26832	346	1.3	< 0.51	< 0.50	< 0.5	33

Typically, a single surface grab sample collected from Kansas' river and streams using EPA approved Cold Vapor Atomic Absorption Spectrometry Method.

KDHE Lake and Wetland Monitoring

Lake and Wetland Program

- Established ~ 1975
- ~ 132 lake and wetlands sampled on a 3-6 year rotational schedule
- Including all 24 federal lakes, most state-administered fishing lakes, and several privately owned by publicly accessible lakes (primarily for water supply)
- Surveys typically evaluate basic water chemistry, nutrient and trophic status, and water clarity


Lake and Wetland Water Samples Collected for Determination of Mercury
300
250
200
150
100
50
0
1975
1976
1979
1980
1981
1982
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
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2010
2011
2012
2013
2014
2015

Mercury Concentrations in Lakes and Wetlands

- **KDHE retains over 4,000 records of total recoverable mercury concentrations in Kansas lakes and wetlands.**
- **95.8% of the total recoverable mercury concentrations are below the minimum quantification limit of 0.5 parts per billion (ppb).**

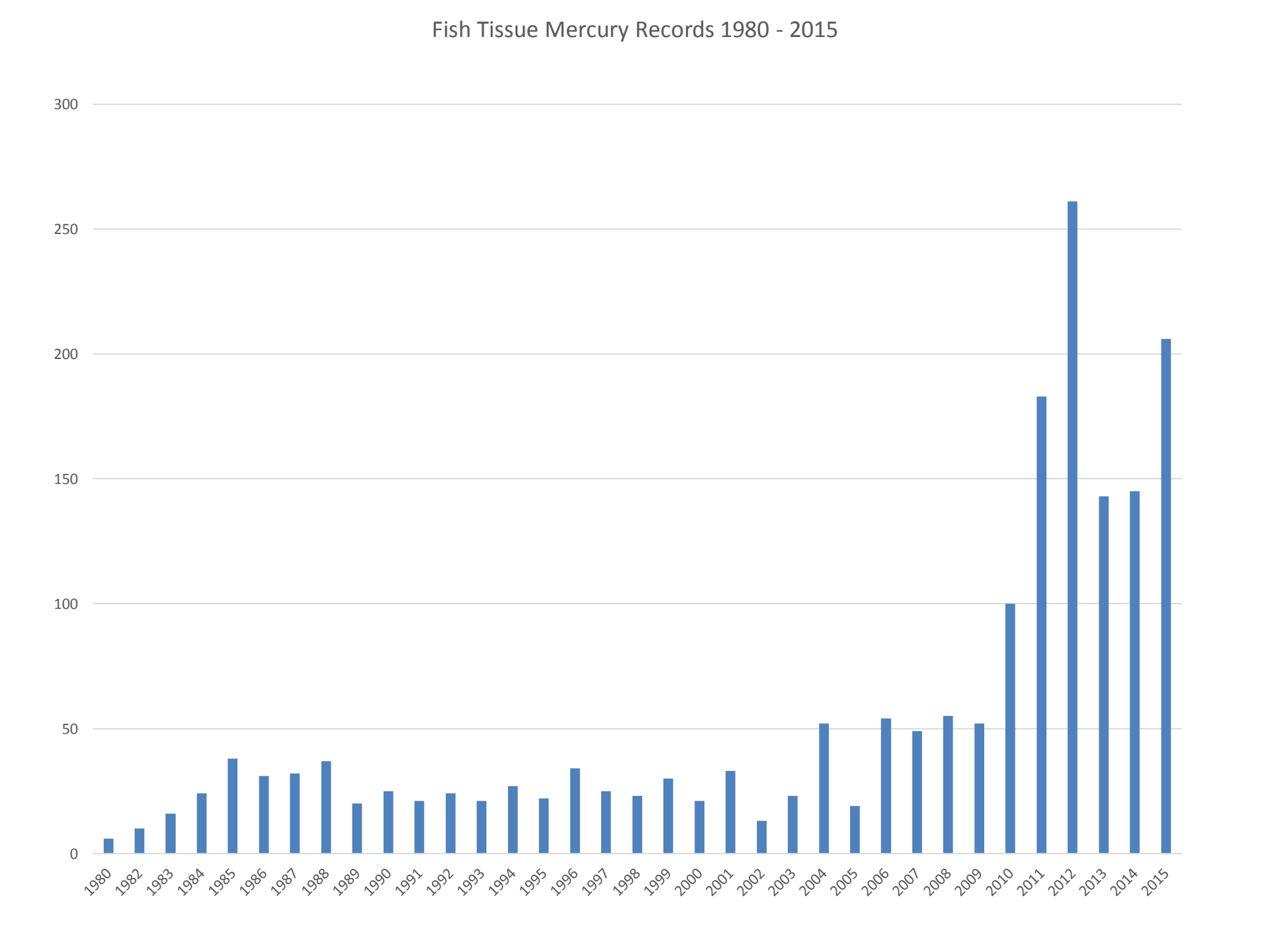
Mercury Statistical Summary (Data years: 1975 – 2015)

Sample Type	Obs.	ND	DT	%DT	Mean	Median	Min	Max
Lake Surface	2794	2638	156	5.6	< 0.54	< 0.50	< 0.5	4.9
Lake Bottom	1007	997	10	1.0	< 0.51	< 0.50	< 0.5	1.2
Wetlands	237	233	4	1.7	< 0.50	< 0.50	< 0.5	1.2

KDHE Fish Tissue Contaminant Monitoring

Fish Tissue Contaminant Program

- Established ~1979
- Fish samples are collected from 30-50 river, stream, and lake sites with assistance provided by Kansas Department of Wildlife and Parks, and Tourism (KDWP&T) and Environmental Protection Agency (EPA) Region 7 personnel, utilizing both random and targeted sampling design
- A random component working collaboratively with probabilistic program to collect mercury data from randomly selected stream and river sites
- A targeted component evaluating stream, river, and lake sites with current fish consumption advisories (biomagnification and bioaccumulation), long-term trend monitoring sites, assessing urban fisheries and lakes, and periodically conducting special investigations


Fish Tissue Mercury Records 1980 - 2015
300
250
200
150
100
50
0
1980
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

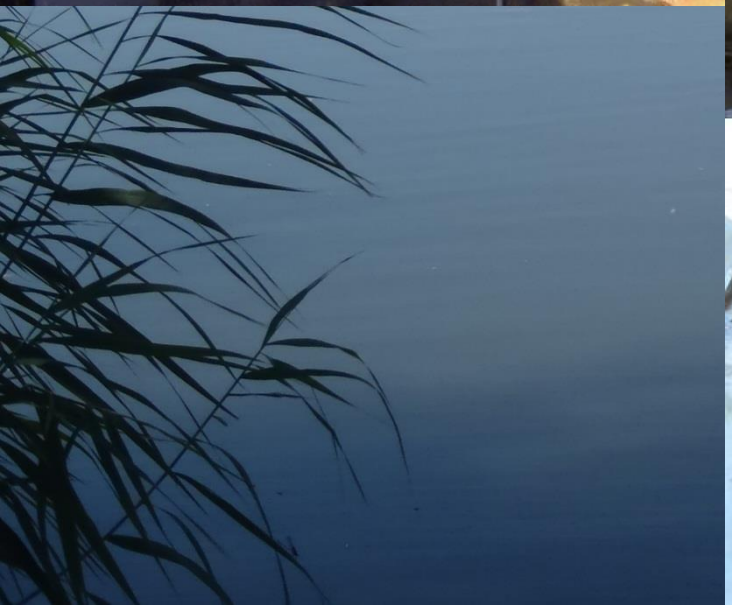
KDHE Mercury Fish Tissue Timeline

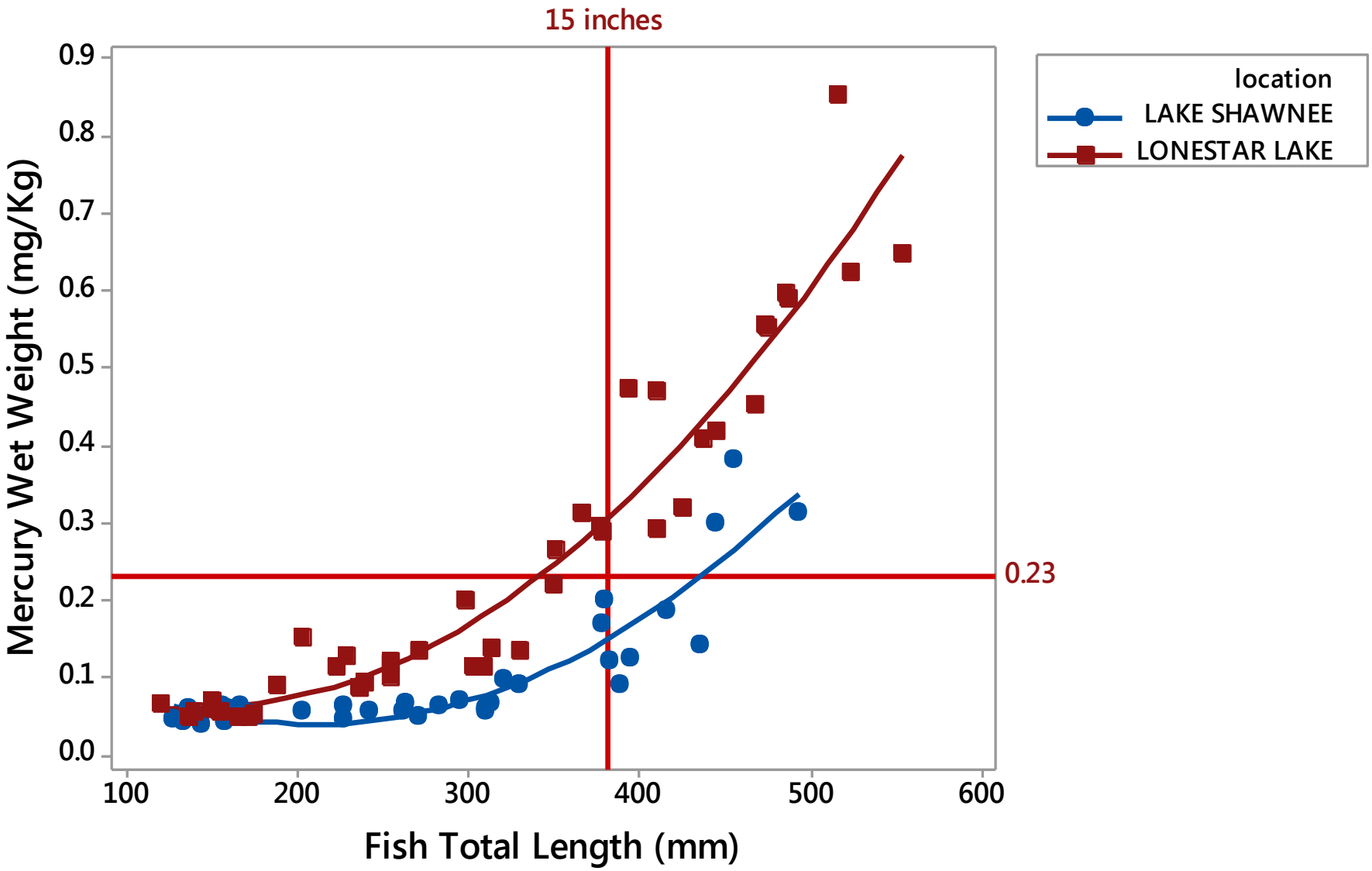
2005 Focus shifted from the organochlorine legacy pollutants (chlordane, DDE, DDT). Local advisories for mercury were issued for Blue River (Johnson Co.) and Little Arkansas River (Wichita vicinity) based on the advice from EPA (i.e., limit consumption of fish from local waters to one meal per week if no local state/tribal health agency advice was available).

2010 USEPA Laboratories in Kansas City, Kansas acquired new analytical instrumentation that allowed mercury analyses using a very small amount of tissue (5mm plugs about the size of a pencil eraser as opposed to 500 g of tissue).

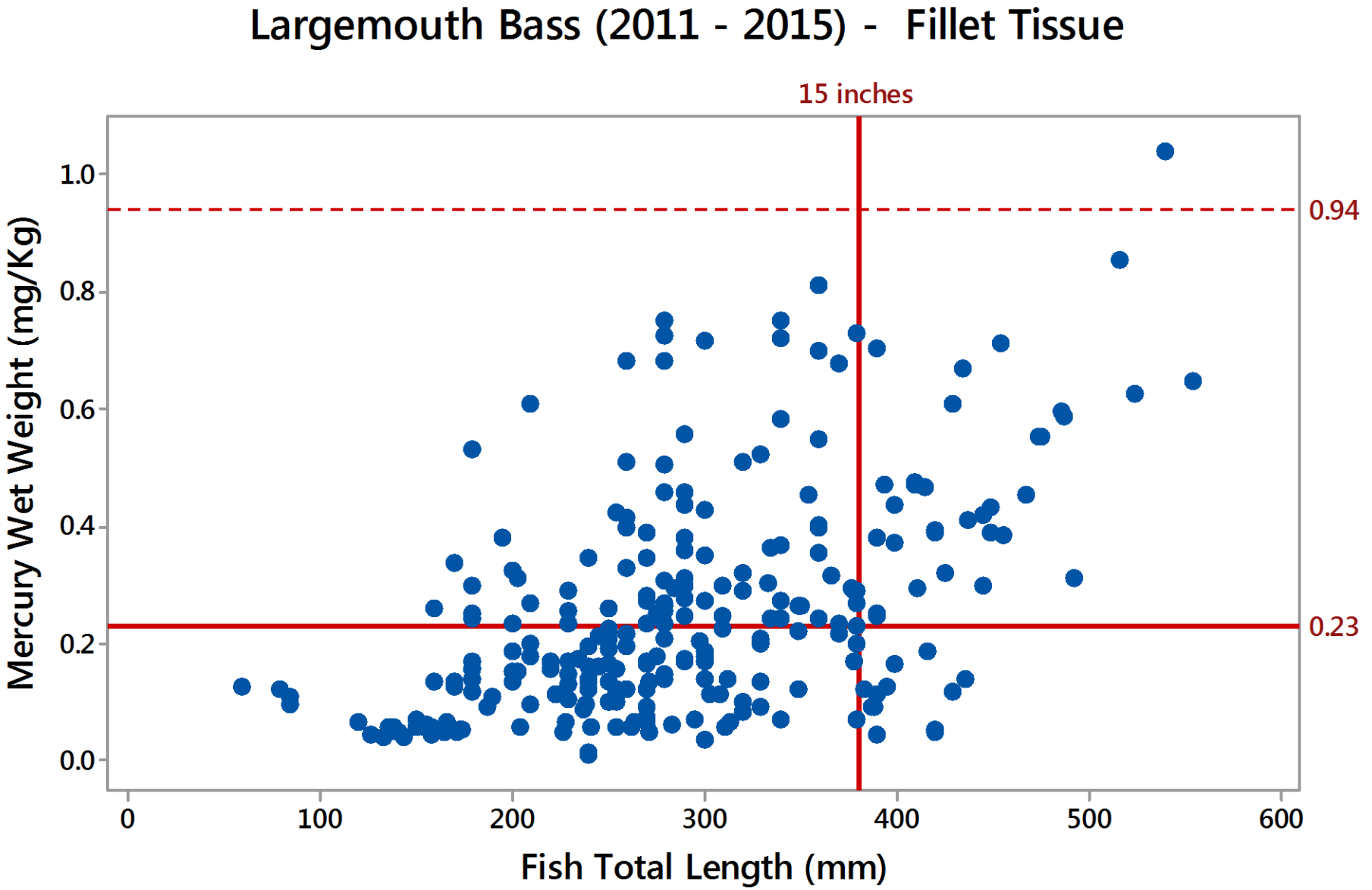
2011 With increase in sample analyses (i.e., going from (3-5 fish) fillet samples per year to 200 single-fish samples per year), KDHE noticed largemouth bass (about the state length limit) were unsafe for high consumption rates

2012 KDHE conducted a special study at two lakes to understand the relationship of mercury concentrations and length of largemouth bass.

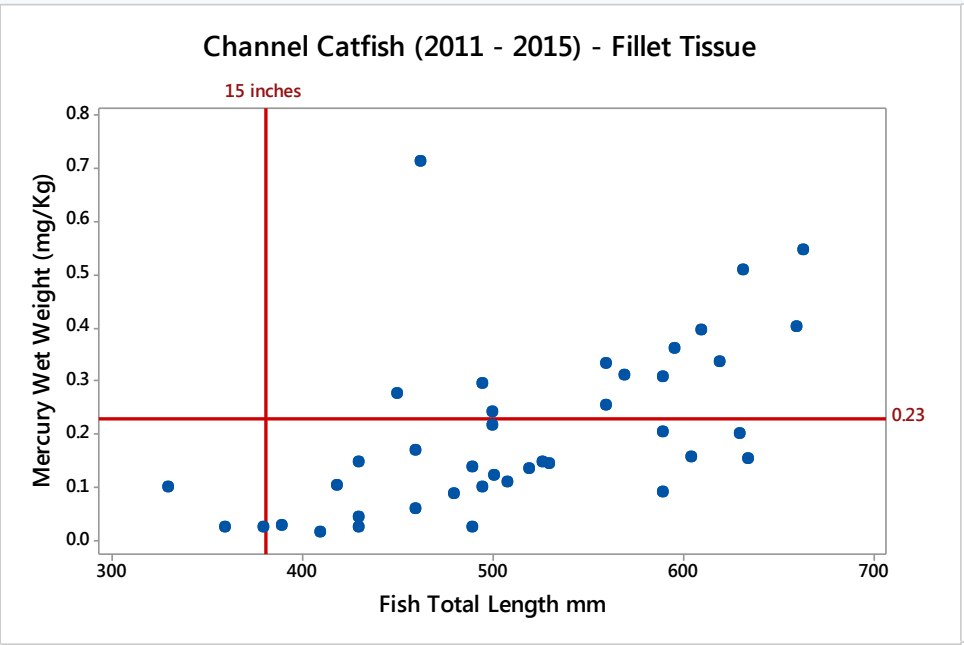


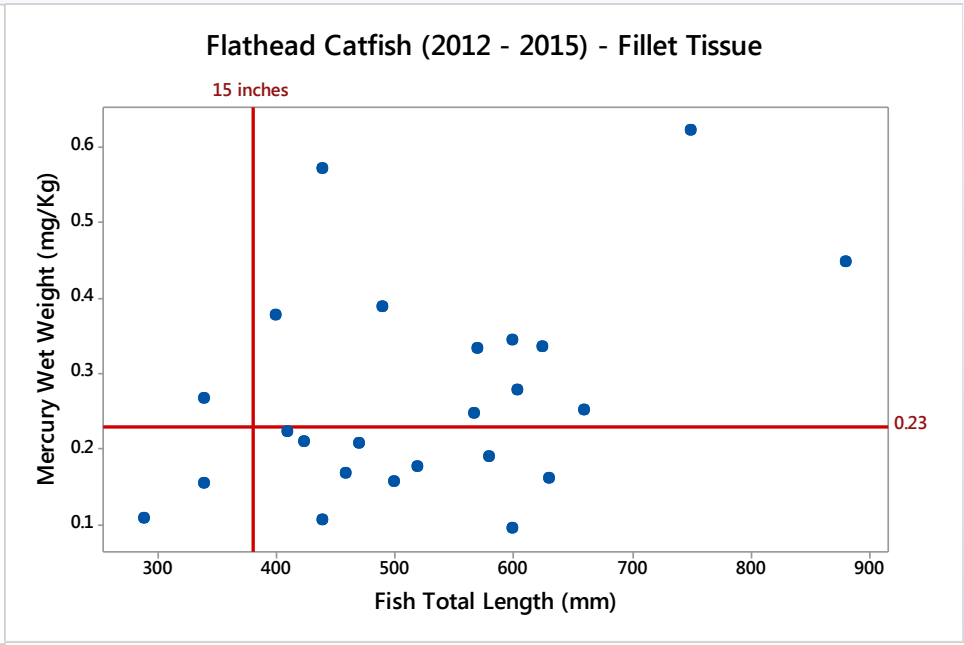


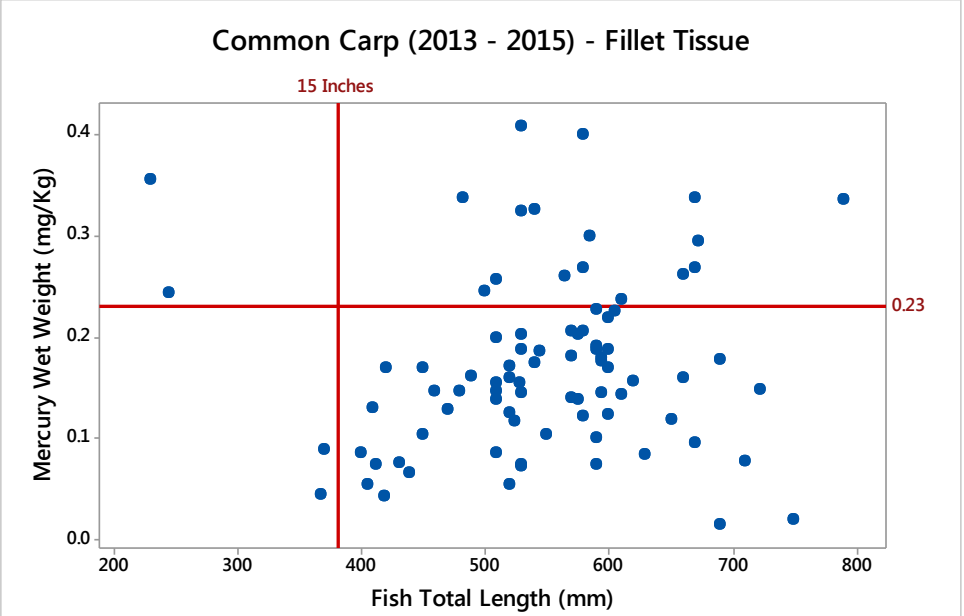
2011 Special Study: An increase in mercury level with length (fish age).

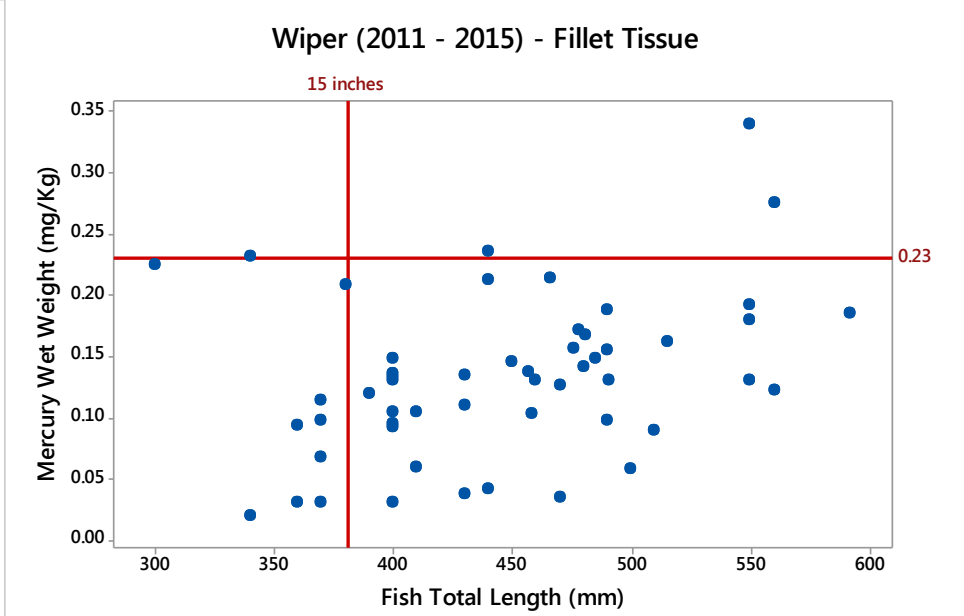


~75% of largemouth bass (above 15 inches) > 0.23 (4 meals/month threshold)

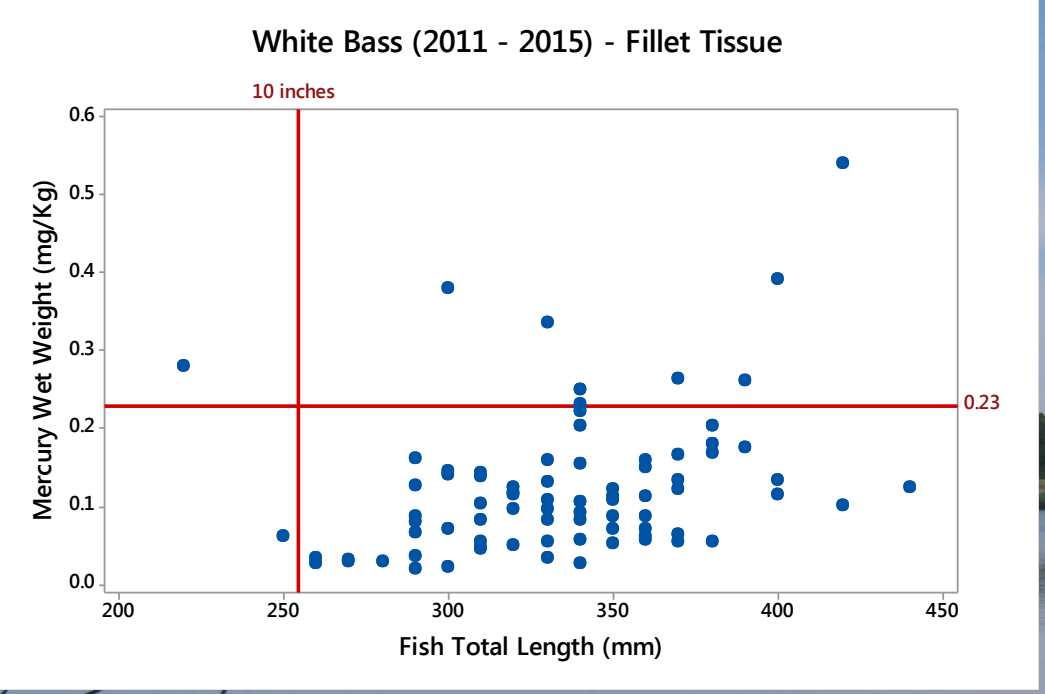


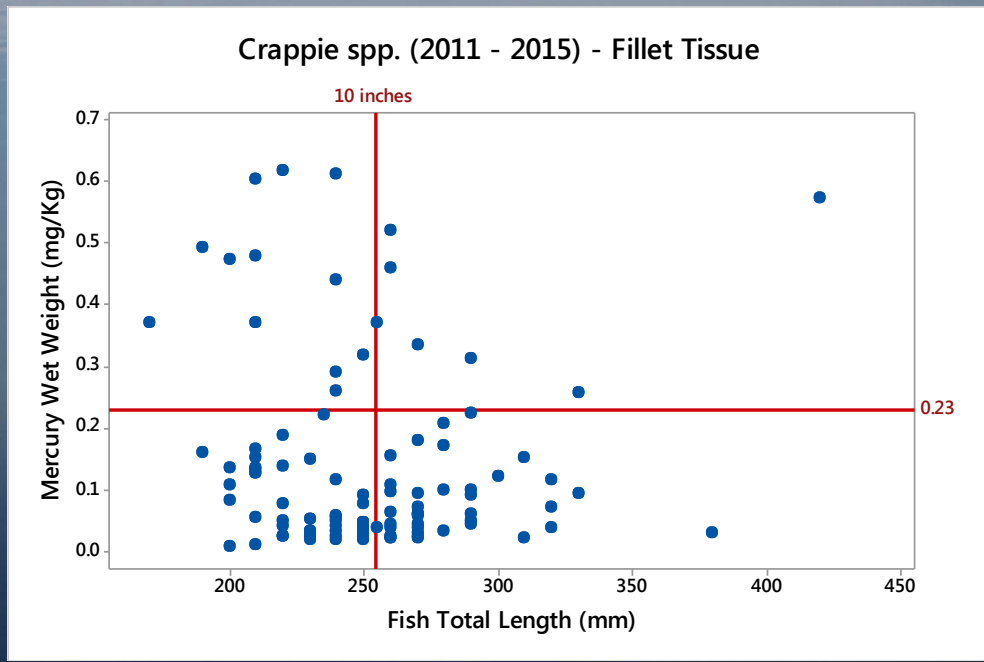






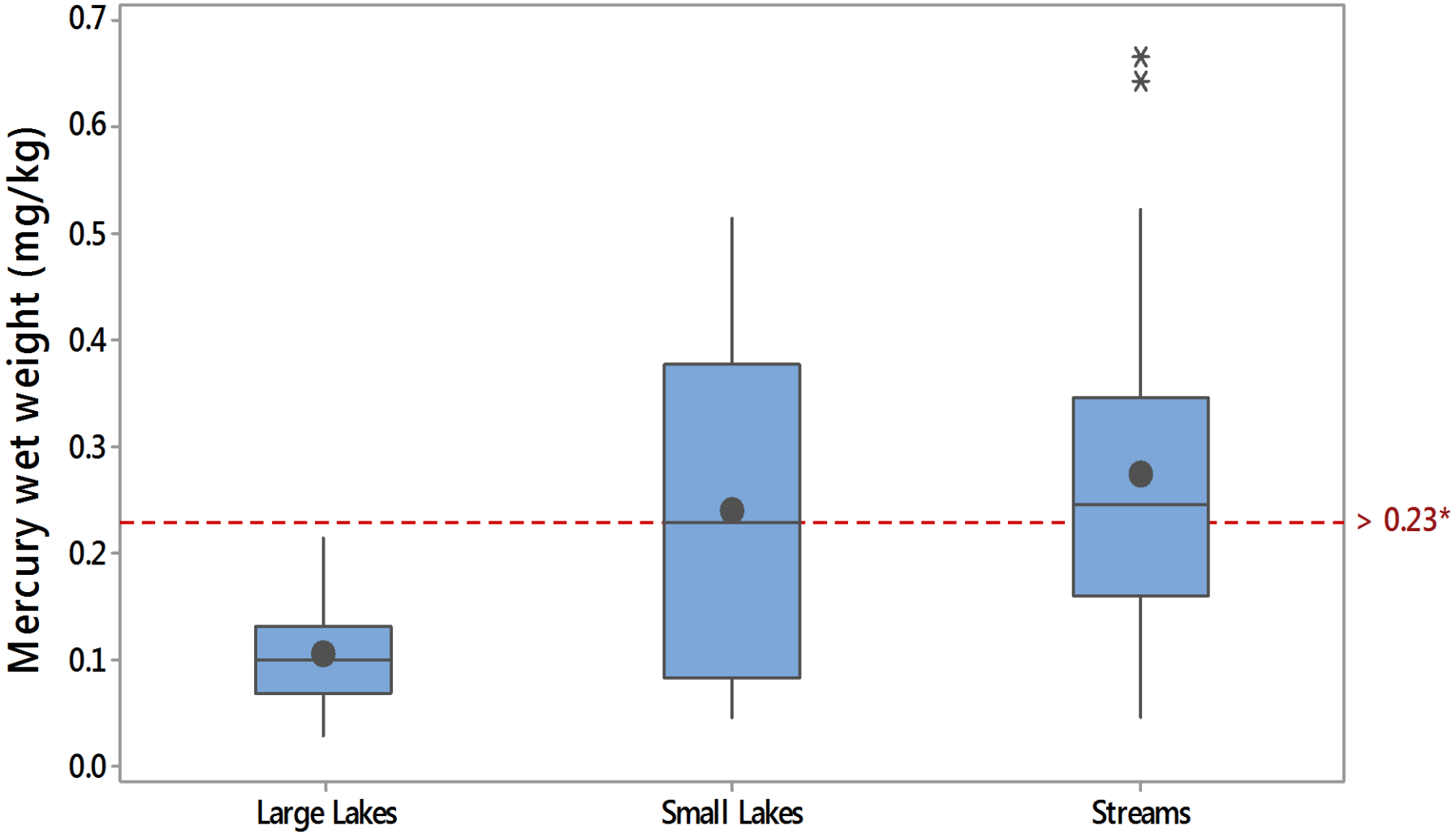
Other species do not appear to accumulate mercury at the same rate.


White Bass (2011 - 2015) - Fillet Tissue
10 inches
0.23
Mercury Wet Weight (mg/Kg)
Fish Total Length (mm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
200
250
300
350
400
450


Crappie spp. (2011 - 2015) - Fillet Tissue
10 inches
0.23
Mercury Wet Weight (mg/Kg)
Fish Total Length (mm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
200
250
300
350
400
450

Kansas Predator Game Fish (> 10 inches)

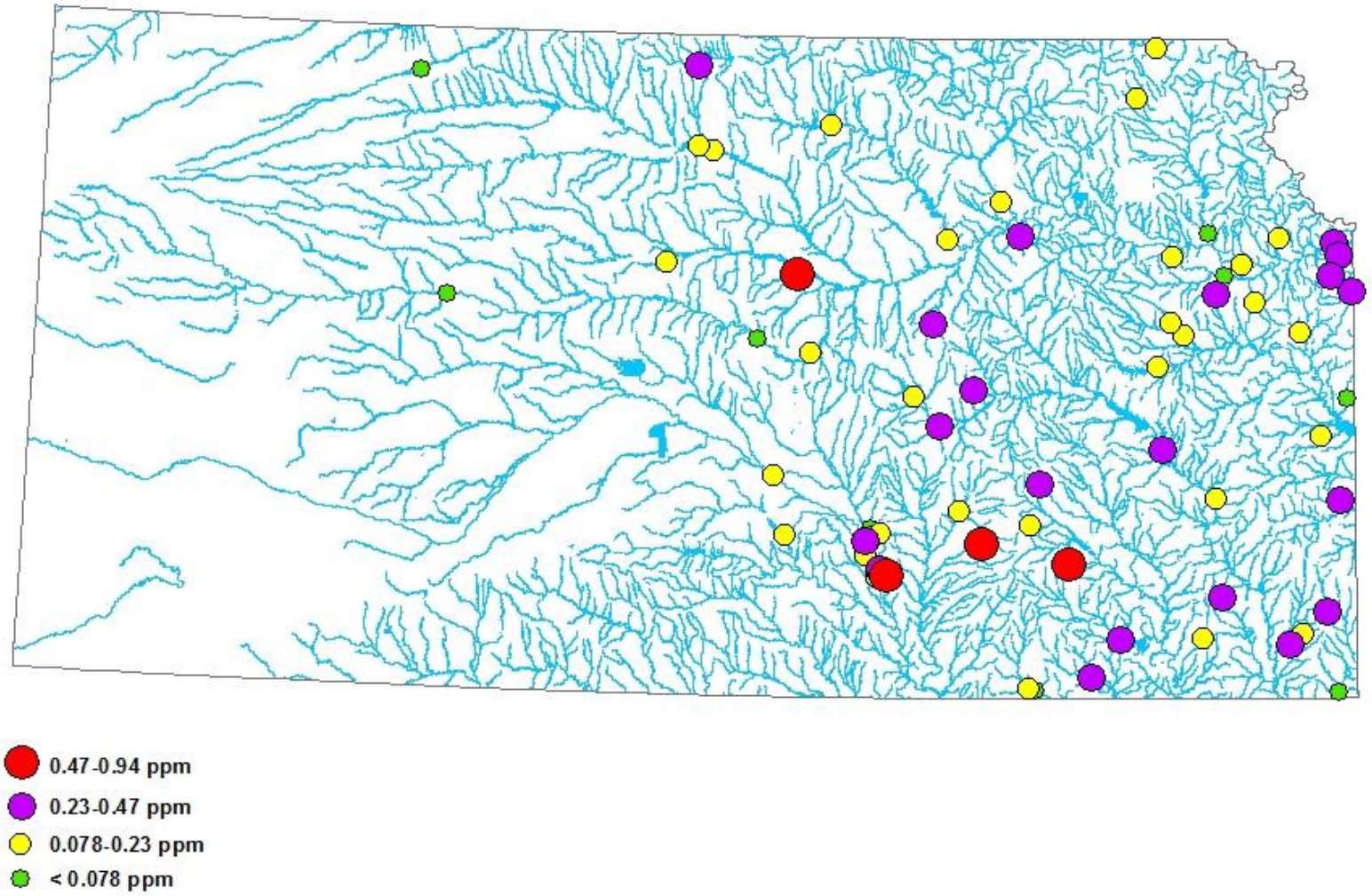
Mercury Plug Data (2011 - 2015)



Predator fish include: largemouth bass, white bass, wiper,crappie, walleye, saugeye, and drum

**4 meals/month threshold*

Mercury Concentration in Game Fish Tissue
2011-2015



Risk Based Fish Consumption Limits

Risk-based consumption limits contained within EPA's (2000) guidance document are consulted to determine the number of fish meals that can be safely eaten based on fish tissue mercury contaminant concentrations found.

In 2013, Kansas recommended the following recommendations because of mercury in fish:

Sensitive Population[1] should restrict consumption of all types of fish not specifically covered by an advisor to **one meal/week.**

Specific to: Largemouth, smallmouth, and spotted bass
Sensitive Populations should restrict consumption to **one meal/month.**
General Public[2] should restrict consumption to **one meal/week.**

[1]Women who are pregnant, may become pregnant, or are nursing and children age 17 or younger.
[2]Men and women 18 years of age or older

KDHE Statewide Mercury Advisory Webpage

http://www.kdheks.gov/news/web_archives/2015/01062015.htm

Health Risk

Your health risk depends on your age, weight, and health, in combination with

- **the amount of fish you eat (3.5 oz. of cooked fish, or about ¾ cup, to be a single serving)[1]**
- **the frequency you eat fish (recommended twice a week)[1]**
- **the type of fish you eat (a variety of fish including oily fish such as salmon, tuna, herring)[1] Low-mercury choices include catfish, trout, cod, tilapia, shrimp**

[1]American Heart Association

Key Take-Home Points

- **At this time, most Kansan's do not need to be concerned about mercury exposure as a result of fish consumption (balancing the risks from mercury exposure with the benefits eating fish).**

- **Specific to largemouth bass, if eaten too frequently, could result in exposure to an unacceptable amount of mercury. The good news, the human body can and does get rid of mercury over time.**

- **Fishing in areas far-removed from known sources of mercury does not mean the fish are less contaminated than in the areas closer to a contamination source.**

Acknowledgements

- Adam Blackwood
- Mike Butler
- Clint Goodrich
- Chris Janssen
- Layne Knight
- Diana Lehmann
- Jeff Scott
- Liz Smith
- Tom Stiles
- Shawn Weber

AND… A number of retirees, KDHE district and central office personnel

Questions


WARNING
CERTAIN FISH FROM THIS RIVER ARE NOT FIT TO EAT CARP CATFISH STURGEON CARPSUCKERS DRUM BUFFALO ALL BOTTOM FEEDING FISH
HEALTH DEPARTMENT

www.kdheks.gov

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